

# Urban Perspectives on Zoonotic Diseases in Livestock

Eric Fèvre

Institute of Infection and Global Health, University of Liverpool  
*and* International Livestock Research Institute, Nairobi, Kenya

Eric.Fevre@liverpool.ac.uk

www.zoonotic-diseases.org

Twitter: @ZoonoticDisease



## Our context: role of urbanization in the emergence of zoonotic pathogens

Understanding the mechanisms leading to the introduction of pathogens into urban environments and their subsequent spread

The focus is on livestock as sources of these pathogens, but where livestock are part of wider ecological networks

Focus on *Escherichia coli*, as an exemplar emerging pathogen, which exists in a diversity of hosts, in the environment, on food, in waste, etc

The geographical focus is the city of Nairobi, Kenya, and its hinterlands

Several components in an interdisciplinary team

- Livestock commodity value chains/food system economics
- Studies on actors and organisation of the food system
- Mapping: geographical, institutional, genetic
- Microbiology and landscape genetics analyses
- Urban planning
- Child health and nutrition



# Interface

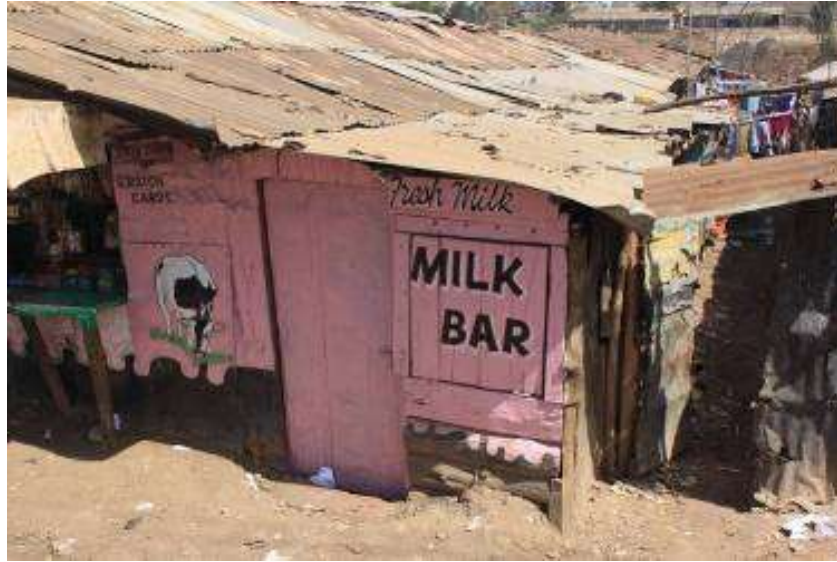


- “A point at which independent systems or diverse groups interact”
- In ecology, it is a physical place: edge, boundary
- Interface
  - Zone of disturbance
  - Zone of interaction
  - Zone of genetic exchange
  - Zone of competition for resources
  - Zone of pathogen transmission
  - Odum (1971): “...the tendency for increased variety and diversity at community junctions...”
- In sociology: it may not be a physical place: “...the PUI (peri-urban interface) not a place, it is a very dynamic process...”
- Physical: Rural/urban, livestock/human, human/food; points of socioeconomic, cultural environmental interaction

# The practical interface

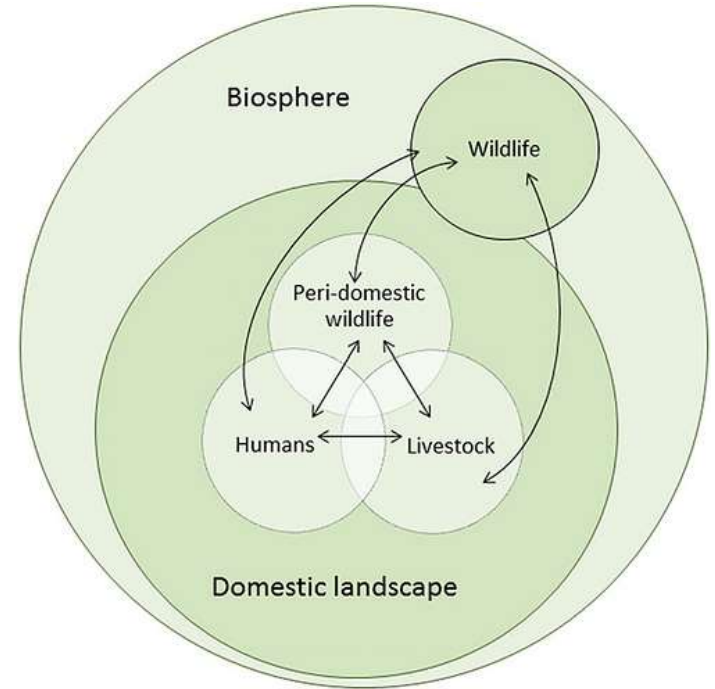


# Interface with livestock and the food system



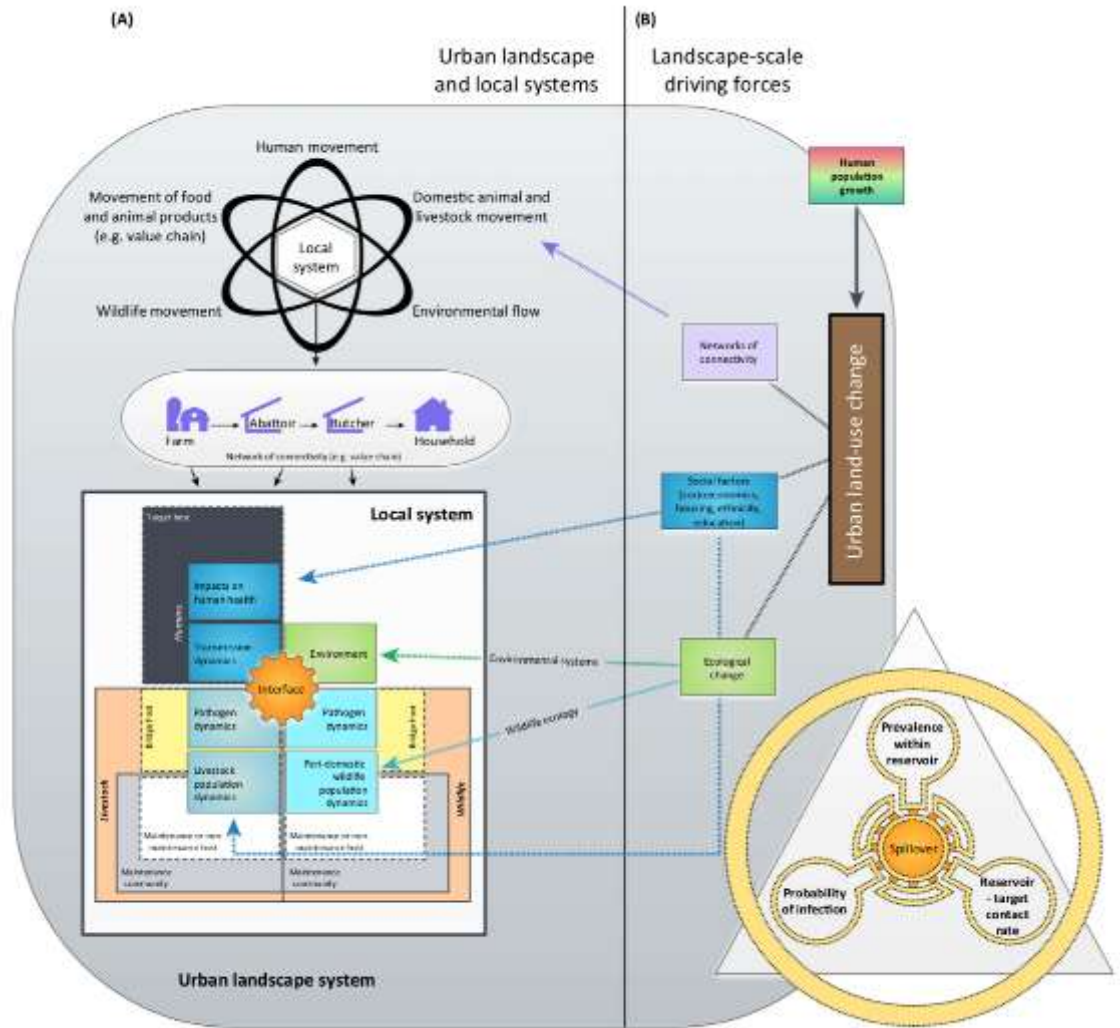
# Complex, but therefore interesting

- Physical and biological interfaces exist within the context of societal and policy interfaces
- The physical world we are measuring is influenced by the non physical interfaces
- Disease transmission may be facilitated or hindered by interventions at any of these interfaces
  - Understanding how they are related matters



*PNAS 2013; Zoonosis emergence linked to agricultural intensification and environmental change, by Delia Grace and others, May 2013.*

Simplify the complexity of urban systems by considering them as a network of interfaces across which pathogens can be transmitted



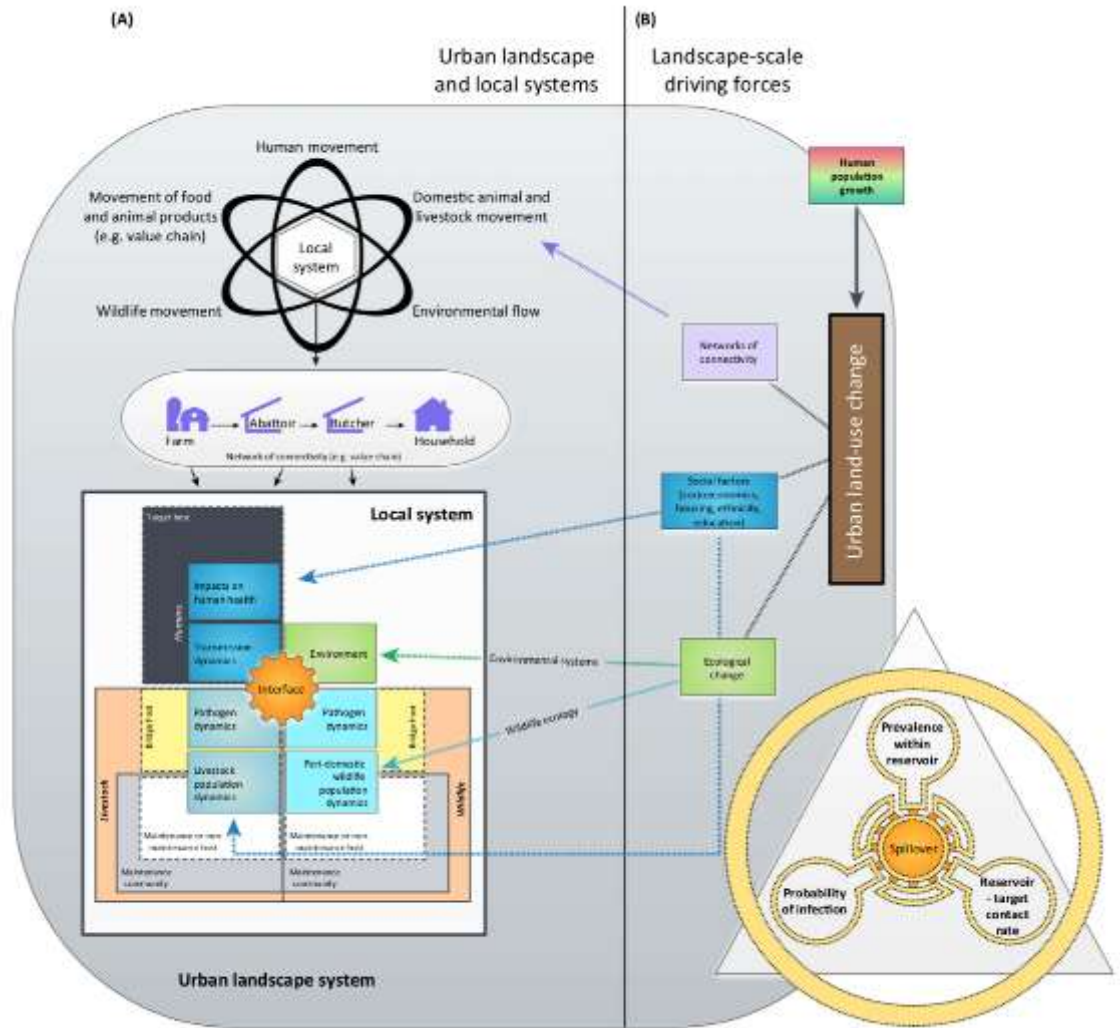
Hassell, Begon, Ward & Fèvre (2016). Urbanization and Disease Emergence: Dynamics at the Wildlife–Livestock–Human Interface. Trends in Ecology and Evolution dx.doi.org/10.1016/j.tree.2016.09.012

Networks of interfaces exist at different scales

Local-scale:  
Households within urban communities linked by local movement of people, livestock and their products, and wildlife

Landscape scale:  
Evolving interfaces driven by the urbanization trends

Hassell, Begon, Ward & Fèvre (2016). Urbanization and Disease Emergence: Dynamics at the Wildlife–Livestock–Human Interface  
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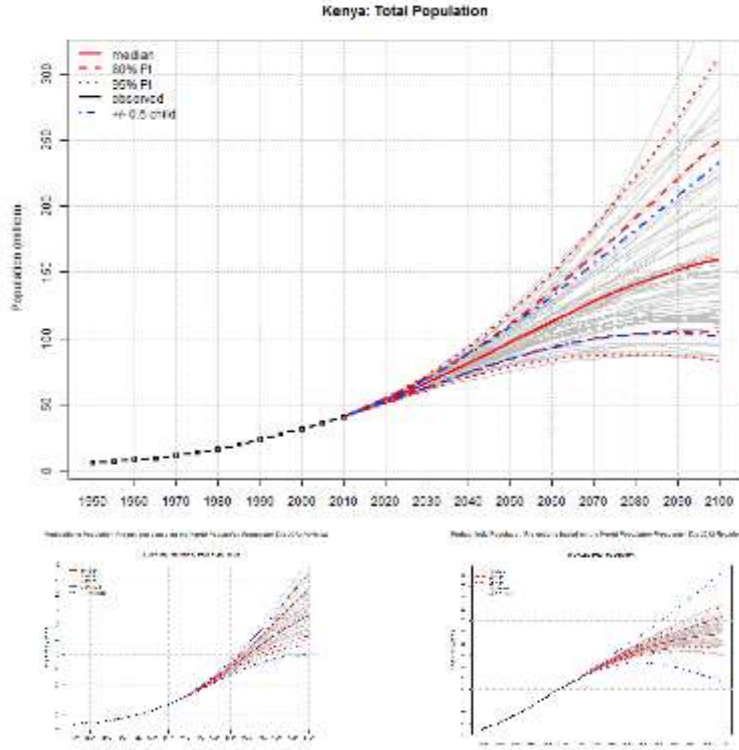
# Urbanisation

- Massive increases in the population of urban and peri-urban (UPU) zones in Africa
  - From 35% of total population 2007 to 51% by 2030
- Impacts on
  - human welfare
  - healthcare provision and delivery
  - sanitation
  - demography
  - economics
  - trade
  - development
  - food production
  - planning
- Impacts of these diverse issues on disease transmission?



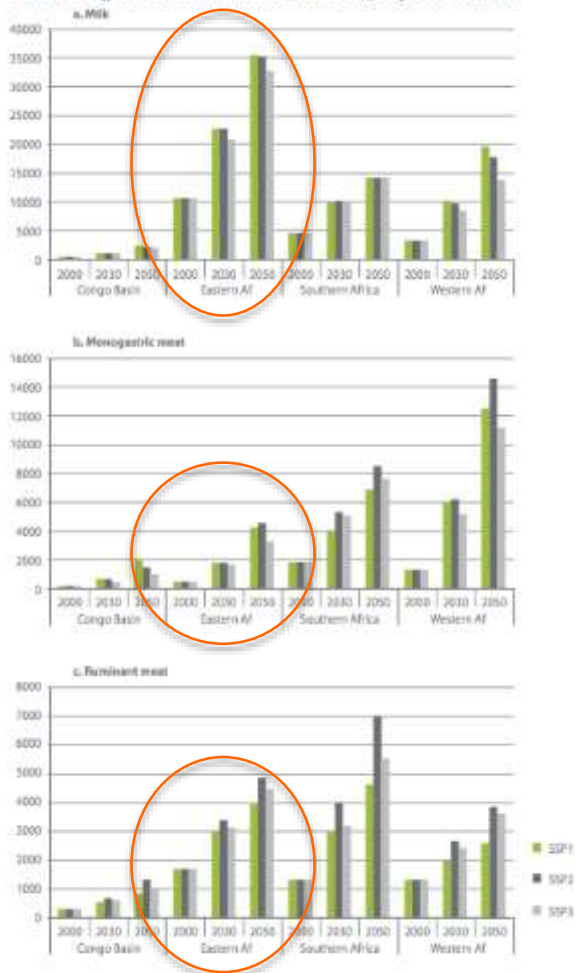
# Urbanisation: Demographic trends

Probabilistic Population Projections based on the *World Population Prospects: The 2012 Revision*



United Nations (2014). Probabilistic Population Projections based on the World Population Prospects: The 2012 Revision. Population Division, DESA. ST/ESA/SER.A/353.  
<http://esa.un.org/unpd/ppp/>

Figure 38 - The total consumption of livestock products (tons 000s) in different regions of sub-Saharan Africa to 2050 by SSP scenario.

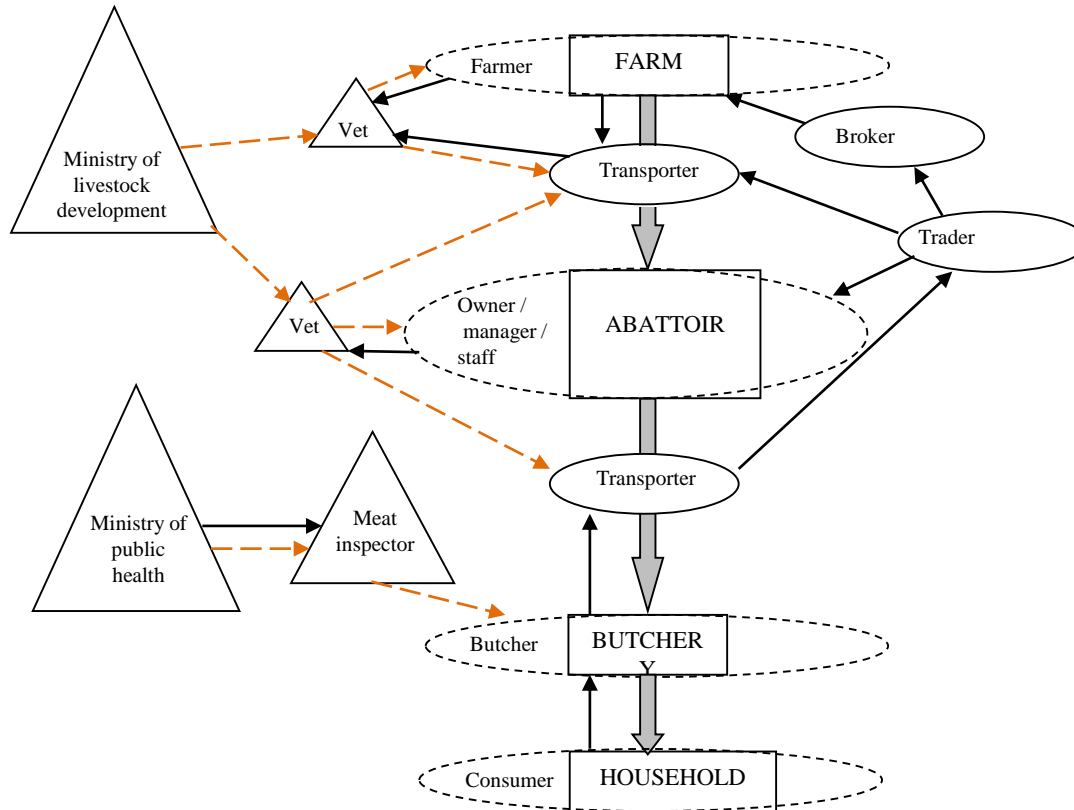


# Trajectories in African animal source food - consumption

Herrero, M., Havlik, P., McIntire, J., Palazzo, A. and Valin, H. 2014. African Livestock Futures: Realizing the Potential of Livestock for Food Security, Poverty Reduction and the Environment in Sub-Saharan Africa. Office of the Special Representative of the UN Secretary General for Food Security and Nutrition and the United Nations System Influenza Coordination (UNSIIC), Geneva, Switzerland, 118 p.

<http://un-influenza.org/?q=content/press-release-african-livestock-futures-realizing-potential-livestock-food-security-poverty>

# Value chains – key element

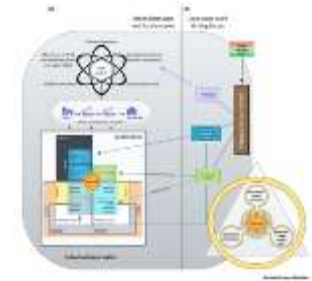


## Legend:

- Movement of animals and products
- Movement of payments
- Movement of public health inspection/information
- Physical location of animals and products
- Business people
- Business people and Ownership
- Public health people



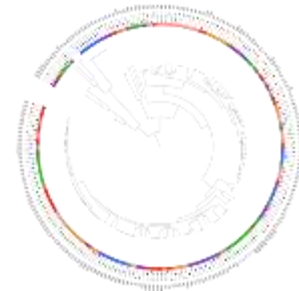
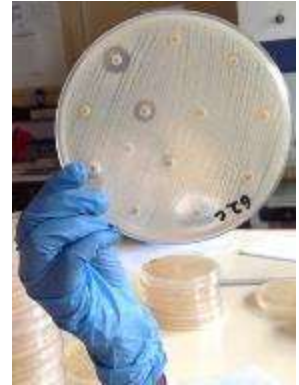
- Value chains are the means of connectivity between urban residents and livestock
- The chain itself crosses ecosystems and is itself an ecological network
- Each node of the chain is an opportunity for generating microbial diversity
- The city is a meta-population (Hanski & Gaggiotti, 2004) connected by people, livestock, livestock products peri-domestic species
- The geography of the city's ecosystems and the way people relate and use their environment helps shape the type of interactions

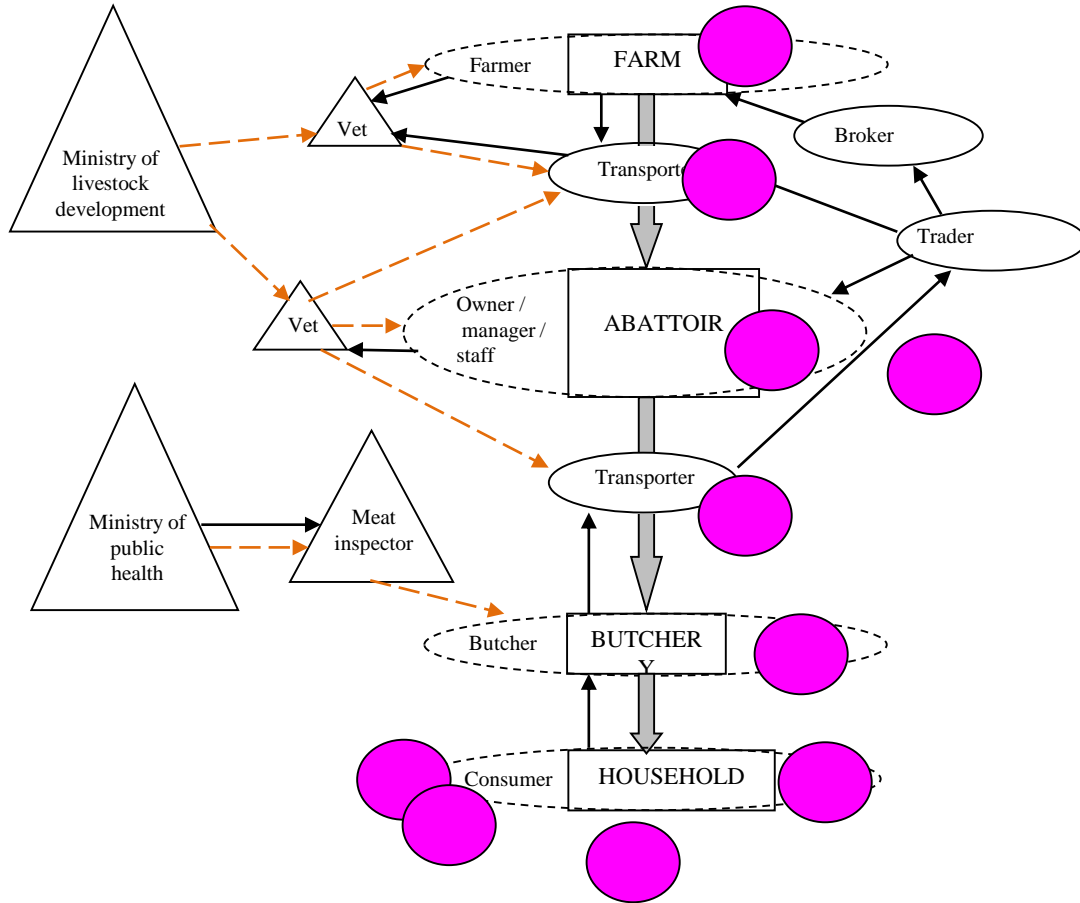


# Landscape genetics approach



- Value chains and household interviews help us understand the socio-economic factors, the contacts, the flows and patterns of trade and consumption
- This is not enough: we need to ground truth our sociological understanding through epidemiology and genetics: landscape genetics
  - *E. coli* as an exemplar microbe
  - Multi-host
  - Excellent tools for landscape genetics
  - Large datasets on microbial diversity from multiple environments/patches/niches within the urban landscape

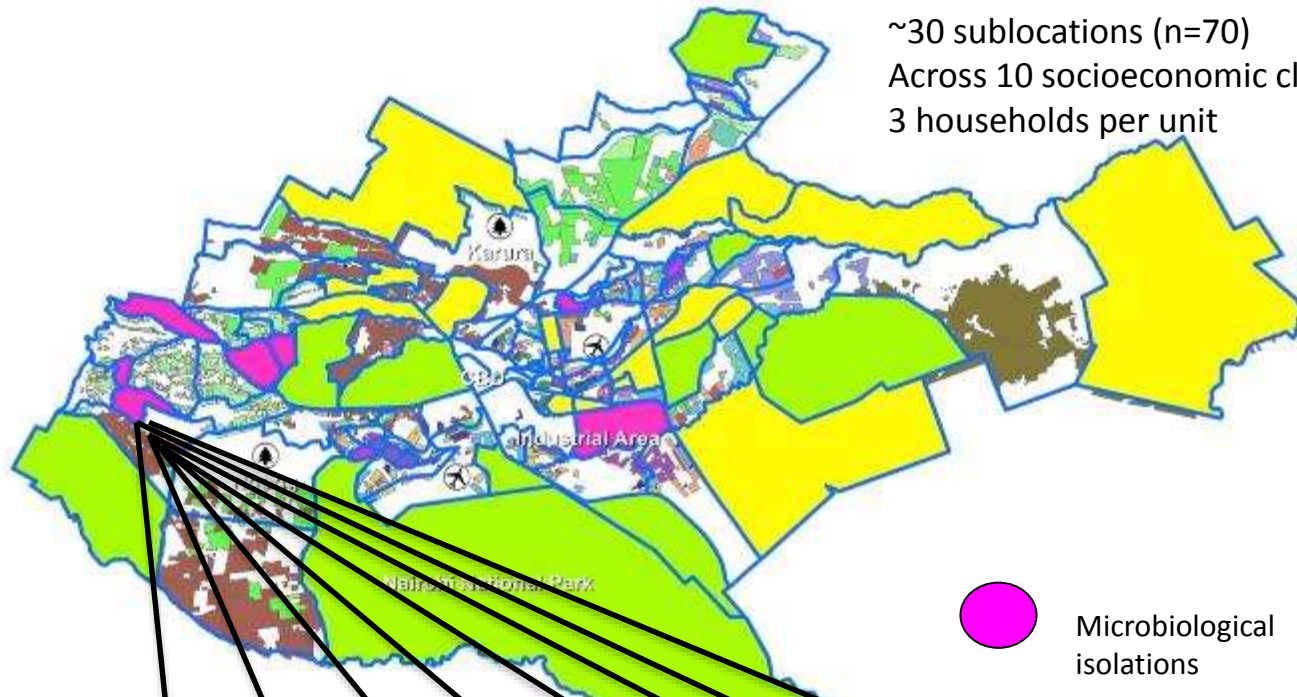




Legend:

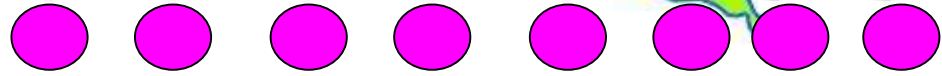
- Movement of animals and products
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- Microbiological isolations





99 households:  
~30 sublocations (n=70)  
Across 10 socioeconomic classes  
3 households per unit

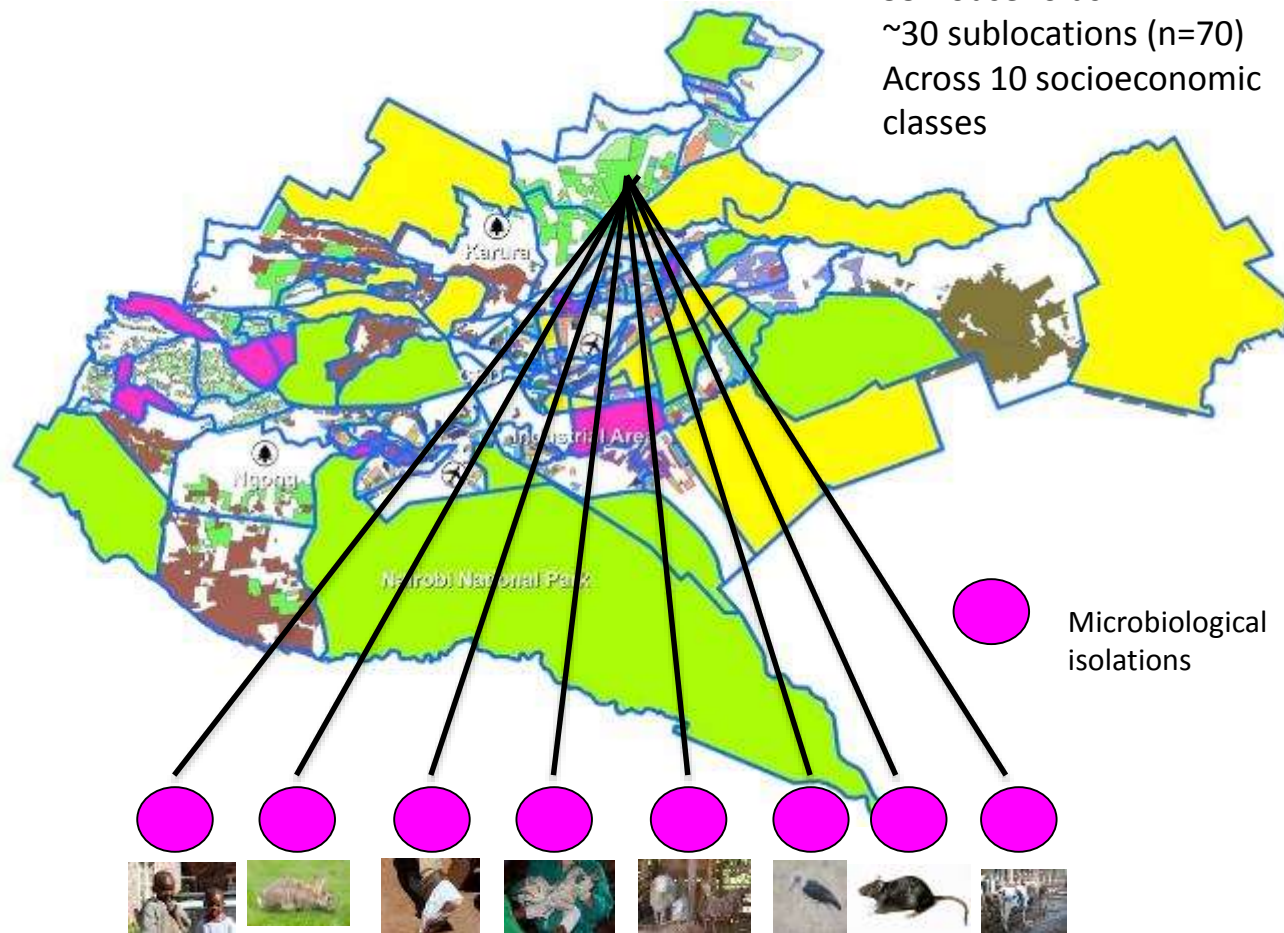
Microbiological isolations







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# Summary

The urban landscape is a complex ecological system

Individual behaviours and decisions influence transmission risks at the interface

The managers of the urban landscape – **individuals, communities, local councils, devolved political structures, national governments, private landowners, corporations, developers, *et al*** – can influence the shape and form of interface

Management of interfaces ought to be pro-active

Elements of the system can be carefully understood, allowing prediction of current and future risks (eg through landscape genetics)

